10-27-00 A

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PTO/SB/05 (4/98)
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UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 C.F.R. § 1.53(b))

Attorney Docket No.	26334.8
First Inventor or Application Identifier	Harold R. Smart, et al.
Title	Valve Positioner System
Express Mail Label No.	EL418586644US

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

ADDRESS TO: **Assistant Commissioner for Patents, Box Patent Application, Washington, DC 20231**

1. [X] * Fee Transmittal Form *(e.g., PTO/SB/17)* *(Submit an original and a duplicate for fee processing)*
2. [X] Specification [*Total Pages* 10] *(preferred arrangement set forth below)*
   - Descriptive title of the Invention
   - Cross References to Related Applications
   - Statement Regarding Fed sponsored R & D
   - Reference to Microfiche Appendix
   - Background of the Invention
   - Brief Summary of the Invention
   - Brief Description of the Drawings *(if filed)*
   - Detailed Description
   - Claim(s)
   - Abstract of the Disclosure
3. [X] Drawing(s) *(35 U.S.C. 113)* [*Total Sheets* 4]
4. Oath or Declaration [*Total Pages* 3]
   - a. [X] Newly executed (original or copy)
   - b. [ ] Copy from a prior application (37 C.F.R. § 1.63(d)) *(for continuation/divisional with Box 16 completed)*
     - i. [ ] DELETION OF INVENTOR(S) Signed statement attached deleting inventor(s) named in the prior application, see 37 C.F.R. §§ 1.63(d)(2) and 1.33(b).

NOTE FOR ITEMS 1 & 13: IN ORDER TO BE ENTITLED TO PAY SMALL ENTITY FEES, A SMALL ENTITY STATEMENT IS REQUIRED (37 C.F.R. § 1.27), EXCEPT IF ONE FILED IN A PRIOR APPLICATION IS RELIED UPON (37 C.F.R. § 1.28).

5. [ ] Microfiche Computer Program *(Appendix)*
6. Nucleotide and/or Amino Acid Sequence Submission *(if applicable, all necessary)*
   - a. [ ] Computer Readable Copy
   - b. [ ] Paper Copy (identical to computer copy)
   - c. [ ] Statement verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

7. [ ] Assignment Papers (cover sheet & document(s))
8. [ ] 37 C.F.R.§3.73(b) Statement *(when there is an assignee)* [ ] Power of Attorney
9. [ ] English Translation Document *(if applicable)*
10. [ ] Information Disclosure Statement (IDS)/PTO-1449 [ ] Copies of IDS Citations
11. [ ] Preliminary Amendment
12. [X] Return Receipt Postcard (MPEP 503) *(Should be specifically itemized)*
13. [ ] * Small Entity Statement(s) *(PTO/SB/09-12)* [ ] Statement filed in prior application, Status still proper and desired
14. [ ] Certified Copy of Priority Document(s) *(if foreign priority is claimed)*
15. [X] Other: Express Mail Certificate

16. **If a CONTINUING APPLICATION,** *check appropriate box, and supply the requisite information below and in a preliminary amendment:*
    [ ] Continuation [ ] Divisional [X] Continuation-in-part (CIP) of prior application No: 09/118,406
    Prior application information: Examiner _____ *Group / Art Unit:* _____
    For CONTINUATION or DIVISIONAL APPS only : The entire disclosure of the prior application, from which an oath or declaration is supplied under Box 4b, is considered a part of the disclosure of the accompanying continuation or divisional application and is hereby i ncorporated by reference. The incorporation can only be relied upon when a portion has been inadvertently omitted from the submitted application parts.

17. CORRESPONDENCE ADDRESS

[ ] *Customer Number or Bar Code Label* *(Insert Customer No. or Attach bar code label here)* or [X] *Correspondence address below*

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Country	USA	*Telephone*	214-651-5533	*Fax*	214-651-5940

Name (Print/Type)	David L. McCombs	*Registration No. (Attorney/Agent)*	32,271
Signature		*Date*	10·25·00

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See 37 C.F.R. §§ 1.27 and 1.28.

TOTAL AMOUNT OF PAYMENT ($) 710.00

Complete if Known	
Application Number	n/a
Filing Date	Herewith
First Named Inventor	Harold R. Smart, et al.
Examiner Name	n/a
Group / Art Unit	n/a
Attorney Docket No.	26334.8

JC917 U.S. PTO 09/699991 10/26/00

METHOD OF PAYMENT (check one)

1. ☐ The Commissioner is hereby authorized to charge indicated fees and credit any overpayments to:

Deposit Account Number: 08-1394

Deposit Account Name: Haynes and Boone LLP

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2. ☒ **Payment Enclosed:**
☒ Check ☐ Money Order ☐ Other

FEE CALCULATION

1. BASIC FILING FEE

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
101	690	201	345	Utility filing fee	710.00
106	310	206	155	Design filing fee	
107	480	207	240	Plant filing fee	
108	690	208	345	Reissue filing fee	
114	150	214	75	Provisional filing fee	

SUBTOTAL (1) ($) 710.00

2. EXTRA CLAIM FEES

		Extra Claims		Fee from below	Fee Paid
Total Claims	4	-20** = 0	X	0	= 0.00
Independent Claims	3	- 3** = 3	X	0	= 0.00
Multiple Dependent					=

**or number previously paid, if greater; For Reissues, see below

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description
103	18	203	9	Claims in excess of 20
102	78	202	39	Independent claims in excess of 3
104	260	204	130	Multiple dependent claim, if not paid
109	78	209	39	** Reissue independent claims over original patent
110	18	210	9	** Reissue claims in excess of 20 and over original patent

SUBTOTAL (2) ($) 0.00

FEE CALCULATION (continued)

3. ADDITIONAL FEES

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
105	130	205	65	Surcharge - late filing fee or oath	
127	50	227	25	Surcharge - late provisional filing fee or cover sheet	
139	130	139	130	Non-English specification	
147	2,520	147	2,520	For filing a request for reexamination	
112	920*	112	920*	Requesting publication of SIR prior to Examiner action	
113	1,840*	113	1,840*	Requesting publication of SIR after Examiner action	
115	110	215	55	Extension for reply within first month	
116	380	216	190	Extension for reply within second month	
117	870	217	435	Extension for reply within third month	
118	1,360	218	680	Extension for reply within fourth month	
128	1,850	228	925	Extension for reply within fifth month	
119	300	219	150	Notice of Appeal	
120	300	220	150	Filing a brief in support of an appeal	
121	260	221	130	Request for oral hearing	
138	1,510	138	1,510	Petition to institute a public use proceeding	
140	110	240	55	Petition to revive - unavoidable	
141	1,210	241	605	Petition to revive - unintentional	
142	1,210	242	605	Utility issue fee (or reissue)	
143	430	243	215	Design issue fee	
144	580	244	290	Plant issue fee	
122	130	122	130	Petitions to the Commissioner	
123	50	123	50	Petitions related to provisional applications	
126	240	126	240	Submission of Information Disclosure Stmt	
581	40	581	40	Recording each patent assignment per property (times number of properties)	
146	690	246	345	Filing a submission after final rejection (37 CFR § 1.129(a))	
149	690	249	345	For each additional invention to be examined (37 CFR § 1 129(b))	

Other fee (specify) _____

Other fee (specify) _____

* Reduced by Basic Filing Fee Paid

SUBTOTAL (3) ($) 0.00

SUBMITTED BY

Complete *(if applicable)*

Name (Print/Type)	David L. McCombs	Registration No. (Attorney/Agent)	32,271	Telephone	(214) 651-5533
Signature				Date	10-25-00

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ATTORNEY DOCKET NO.26334.8

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Harold R. Smart, et al.	§		
		§		
Serial No.:	N/A	§	Group Art Unit:	Unknown
		§		
Filed:	Herewith	§	Examiner:	Unknown
		§		
For:	VALVE POSITIONER SYSTEM	§		

Commissioner for Patents
Box Patent Application
Washington, D.C. 20231

EXPRESS MAIL CERTIFICATE

Express Mail Number: EL418586644US

Date of Deposit: October 25, 2000

I hereby certify that the following attached papers and fee:

1. Patent Application Transmittal and Fee Transmittal with duplicate copy attached;
2. Continuation-in-Part Patent Application consisting of: 10 pages of Specification;
3. 4 Informal Drawing sheets;
4. a signed Declaration;
5. a Check in the amount of $710.00; and
6. a Return Postcard.

are being deposited with United States Postal Service "Express Mail Post Office to addressee" to the Assistant Commissioner for Patents, Washington, D. C. 20231.

Debbie Ludwig

Debbie Ludwig

10-26-2000

Date

d-833863.1

Attorney Docket No.: 26334.8

VALVE POSITIONER SYSTEM

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D-826266.1

Attorney Docket No.: 26334.8

EXPRESS MAIL NO.: EL418586644US DATE OF DEPOSIT: 10 26 2000

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Debbie Ludwig
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Debbie Ludwig
Signature of person mailing paper and fee

VALVE POSITIONER SYSTEM

Cross Reference

This application is a Continuation-in-Part application of U.S. Patent Application Serial No. 09/118,406 which was filed on July 17, 1998.

Background of the Invention

The present invention relates generally to valve position systems, and more particularly, to a flexure used in a current-to-pneumatic (I/P) converter, a low cost I/P converter, and a dynamically balanced pneumatic amplifier.

One major purpose of an I/P converter is to produce a pneumatic pressure proportional to a given electrical current. This produced pressure may be referred to as a signal pressure. This signal pressure is traditionally amplified, both in pressure and volume, and fed to a pneumatic actuator used to position a valve in a valve positioner system as described in the U.S. Patent Application Serial No. 09/118,406, which is assigned to the same assignee and incorporated herein by reference.

In addition, in a typical 2-stage valve positioner, the second stage is used to amplify both the flow capacity and pressure range of the output since a

typical I/P converter has a low flow and minimal pressure gain. Masoneilan and other pneumatic control valve positioner manufacturers have traditionally used two types of pneumatic amplifiers. One type is a spool valve design. The second type is of a pneumatic relay, which is commonly called a relay. The spool valve provides a very consistent dynamic response, but is difficult to manufacture to ensure that it performs well in a steady state. The traditional relay type is easy to manufacture and has a good steady state performance, but lacks in its ability to perform with a consistent dynamic response. Inherent to the design of the relay is an end loading of a supply plug on a corresponding supply seat during steady state operation of the relay. This end loading is due to the pressure drop across the plug and the force due to a supply plug spring. During a dynamic response of the relay, a signal pressure must be increased sufficiently to overcome this end loading before any additional output flow is established. This change in signal pressure with no corresponding output flow is referred to as a flow deadband.

For the improvement of the valve positioner system, what is needed is a low cost I/P converter for use in an electro-pneumatic positioner which operates with supply pressures between 20 psi and 100 psi.

What is also needed is a flexure used in the I/P converter for use in the electro-pneumatic positioner. The characteristics of this flexure must provide temperature and vibration resistance for the I/P converter. Also this flexure should be capable of providing sufficient gain required for operating the electro-pneumatic positioner.

What is further needed is an improved design of the relay type amplifier, which provides consistent dynamic response with minimal effect on the manufacturability or its steady state performance.

Summary of the Invention

A dynamically balanced pneumatic relay is disclosed. In one example, the relay has a balance plug, a supply plug positioned on top of the balance plug, a bead chain connecting the balance plug and the supply plug, and a vent plug positioned on top of the supply plug. The relay integrated with the balance plug, the supply plug, and the vent plug avoids a flow deadband during which a signal pressure generated by the amplifier changes with no corresponding output flow. This is accomplished because the dead band is caused by forces deriving from an end loading, and the end load is function of a supply pressure and the addition of the balance plug adds a force (which is also a function of the supply pressure) thereby opposing forces from the end loading. The relay thus provides both a reliable steady state amplifier performance and a consistent dynamic response.

In another example, the relay further comprises a baffle positioned on top of the vent plug for counteracting a back pressure created during a venting process.

A current-to-pneumatic converter used in an electro-pneumatic positioner is also disclosed. In one example, the converter has a flexure-nozzle arrangement to produce a signal pressure proportional to a given electrical current. The converter comprises a flat strip made of magnetic material located in proximity to a nozzle, and a flow regulator having a flat spring securing a plug in a seat within the regulator, wherein the regulator maintains a near constant fluid feeding the nozzle.

In another example, a design of a current-to-pneumatic converter of an electro-pneumatic positioner is disclosed. The converter comprises a cantilevered flexure integrally secured to a molded spring support, a first bias spring positioned on a first side of the flexure, and a second bias spring positioned on a second side of the flexure. The flexure, the molded spring

support, and the bias springs are centered around a nozzle of the converter. The thickness of the flexure is locally reduced in an area not integrated into the molded spring support. The converter thus designed has a predetermined temperature and vibration resistance of the flexure.

Brief Description of the Drawings

Fig. 1 illustrates a portion of a current-to-pneumatic converter.

Fig. 2 illustrates a detailed view of a flexure assembly within the converter of Fig. 1.

Fig. 3A illustrates a top view of a flow regulator.

Fig. 3B illustrates a sectional view of a flow regulator of Fig. 3A.

Fig. 4A illustrates a sectional view of a relay used in the valve positioner system according to one example of the present invention.

Fig. 4B illustrates a sectional view of a relay used in the valve positioner system according another example of the present invention.

Description of the Preferred Embodiment

This application incorporates by reference in its entirety the co-pending parent application U.S. Patent Application Serial No. 09/118,406 which was filed on July 17, 1998.

Referring to Fig. 1, a portion of an I/P converter 10 is shown. As described above, the purpose of the I/P converter is to generate a signal pressure proportional to a given electrical current. One improved design of a low cost I/P converter according to one example of the present invention uses a flexure-nozzle arrangement to produce the signal pressure. A flexure 12 is a flat strip located in close proximity to a nozzle 14. The flexure 12 is acted on by a variable magnetic force produced by a current flowing through a wire coil 16, thereby creating a back pressure in the nozzle. The flexure is further integrated with a

molded spring support 18 and two bias springs 20. There is an adjusting screw 22 sitting on top of the I/P converter.

Referring now to Fig. 2, a detailed view of a flexure assembly is shown. As it is clearly shown, the flexure has a portion 12a embedded within the molded spring support, and a cantilevered portion 12b. The cantilevered flexure 12 allows for the flexure to expand and contract perpendicular to the nozzle 14, thereby maintaining a constant distance between the flexure and nozzle under all temperatures. In addition, the molded spring support 18 maintains a correct alignment of the bias springs 20, which are used to set the zero condition of the I/P converter and further enhance the strength of the flexure assembly. The bias spring 20 also increases the stiffness of the entire flexure assembly. It is known that the stiffer the flexure assembly the higher the natural frequency, and the higher the natural frequency the greater the vibration resistance created in the I/P converter.

The flexure is made of a soft magnetic material to produce both the flexibility and the magnetic effect. As a general rule, a given amount of magnetic material will only produce a limited amount of electro-magnetic force. Therefore a particular thickness of the flexure is required to produce adequate magnetic force. This may cause an increase in the thickness of the flexure, and further create excessive stiffness. To solve this problem, the thickness of the flexure is reduced locally on the cantilever portion 12b of the flexure. Consequently, this design creates a flexure with adequate magnetic material but with optimal stiffness.

This flexure assembly design utilizes a one-piece cantilever flexure made from soft magnetic material with a locally decreased thickness, and provides for a constant air gap at all temperatures.

Referring now to Figs. 3A and 3B, a top view and a sectional view of a flow regulator are shown. Also, with regard to the I/P converter 10 as shown in

Fig. 1, it is further understood that a flow of a predetermined liquid feeding the nozzle must be maintained at a near constant rate under all supply pressures. A flow regulator 30 is conventionally used to perform this task. The flow regulator 30 has a small plug 32 and a seat ring 34. The plug 32 is preferred to seat correctly in the seat ring 34 all the time during the operation of the I/P converter. A spring is usually used to ensure the plug 32 is seated appropriately in the seat ring 34. Traditional compression and tapered springs have been used to perform this task. In one example of the present invention, a "flat spring" 36 is used to perform this task. The flat spring 36 not only provides a spring force as a conventional spring, it also centers the plug 32 in the seat ring 34.

The flat spring requires significantly less space than a traditional compression spring. It is also easier to assemble than the compression spring and improves the centering of the plug.

Referring now to Fig. 4A, a sectional view of a relay amplifier 40 (a "relay") used in the valve positioner system is shown. As it is known, there are generally two types of amplifiers used in the valve positioner system, the spool valve type and the relay type. The relay amplifier does not perform as well dynamically as the spool valve type amplifier because it has an inherent flow dead band. This flow dead band causes a condition where the signal pressure to the relay can be changed with no corresponding relay output flow change.

To minimize the flow dead band, a plug assembly 42 of the relay is designed to be "balanced" with the input and output pressures. This balancing objective is achieved by adding a balance plug 44 and sizing the areas the air pressure acts thereon. This balance plug 44 is secured to a supply plug 46 using a bead chain 47. This bead chain 47 provides for a secure attachment while providing minimal opportunity for side loading the balance plug 44. It is known that side loading adds additional undesirable dead band due to frictions created. Since the dead band is caused by forces deriving from the end loading, and the

end load is function of a supply pressure, the addition of the balance plug adds a force which is also a function of the supply pressure to oppose forces from the end loading.

With the balance plug 44 installed, a steady state condition is achieved in the relay, but does not work well during venting conditions for high output pressures. While venting from high output pressures a back pressure is established which acts on a vent plug 48 and opens the supply plug 46.

Referring now to Fig. 4B, the relay is shown according to another example of the present invention. To help counteract with the undesired back pressure force, a baffle 50 is added to the vent plug 46 in the pathway of the venting air stream. The forces on this baffle due to the air stream are sufficient to counteract the back pressure forces. The addition of the baffle allows the balanced relay to be used with higher supply pressures.

The above disclosure provides many different embodiments, or examples, for implementing different features of the invention. Specific examples of components, and processes are described to help clarify the invention. These are, of course, merely examples and are not intended to limit the invention from that described in the claims.

While the invention has been particularly shown and described with reference to the preferred embodiment thereof, it will be understood by those skilled in the art that various changes in form and detail may be made therein without departing from the spirit and scope of the invention, as set forth in the following claims.

WHAT IS CLAIMED IS:

1. A amplifier of a dynamically balanced pneumatic relay type, the amplifier comprising:

a balance plug;

a supply plug positioned on top of the balance plug;

a bead chain connecting the balance plug and the supply plug; and

a vent plug positioned on top of the supply plug,

wherein the relay integrated with the balance plug, the supply plug, and the vent plug avoids a flow deadband in which a signal pressure generated by the amplifier changes without corresponding output flow, thereby providing both a reliable steady state relay performance and a consistent dynamic response.

2. The amplifier of claim 1 further comprising a baffle positioned on top of the vent plug for counteracting a back pressure created during a venting process.

3. A current-to-pneumatic converter used in an electro-pneumatic positioner, the converter having a flexure-nozzle arrangement to produce a signal pressure proportional to a given electrical current, the converter comprising:

a flat strip made of magnetic material located in proximity to a nozzle; and

a flow regulator having a flat spring securing a plug in a seat within the regulator,

wherein the regulator maintains a near constant fluid feeding the nozzle.

4. A current-to-pneumatic converter of an electro-pneumatic positioner, the converter comprising:

a cantilevered flexure integrally secured to a molded spring support,

a first bias spring positioned on a first side of the flexure; and

a second bias spring positioned on a second side of the flexure,

wherein the flexure, the molded spring support, and the bias springs are centered around a nozzle of the converter, wherein a thickness of the flexure is locally reduced in an area not integrated into the molded spring support, thereby providing a predetermined temperature and vibration resistance for the converter.

VALVE POSITIONER SYSTEM

Abstract

A dynamically balanced pneumatic relay amplifier and a current-to-pneumatic converter are disclosed. The relay has a balance plug, a supply plug positioned on top of the balance plug, a bead chain connecting the balance plug and the supply plug, and a vent plug positioned on top of the supply plug. The relay also includes a baffle positioned on top of the vent plug. The converter, used in an electro-pneumatic positioner, comprises a flat strip made of magnetic material located in proximity to a nozzle, and a flow regulator having a flat spring securing a plug in a seat within the regulator. The converter also includes a cantilevered flexure integrally secured to a molded spring support, a first bias spring positioned on a first side of the flexure, and a second bias spring positioned on a second side of the flexure. The thickness of the flexure is locally reduced in an area not integrated into the molded spring support.

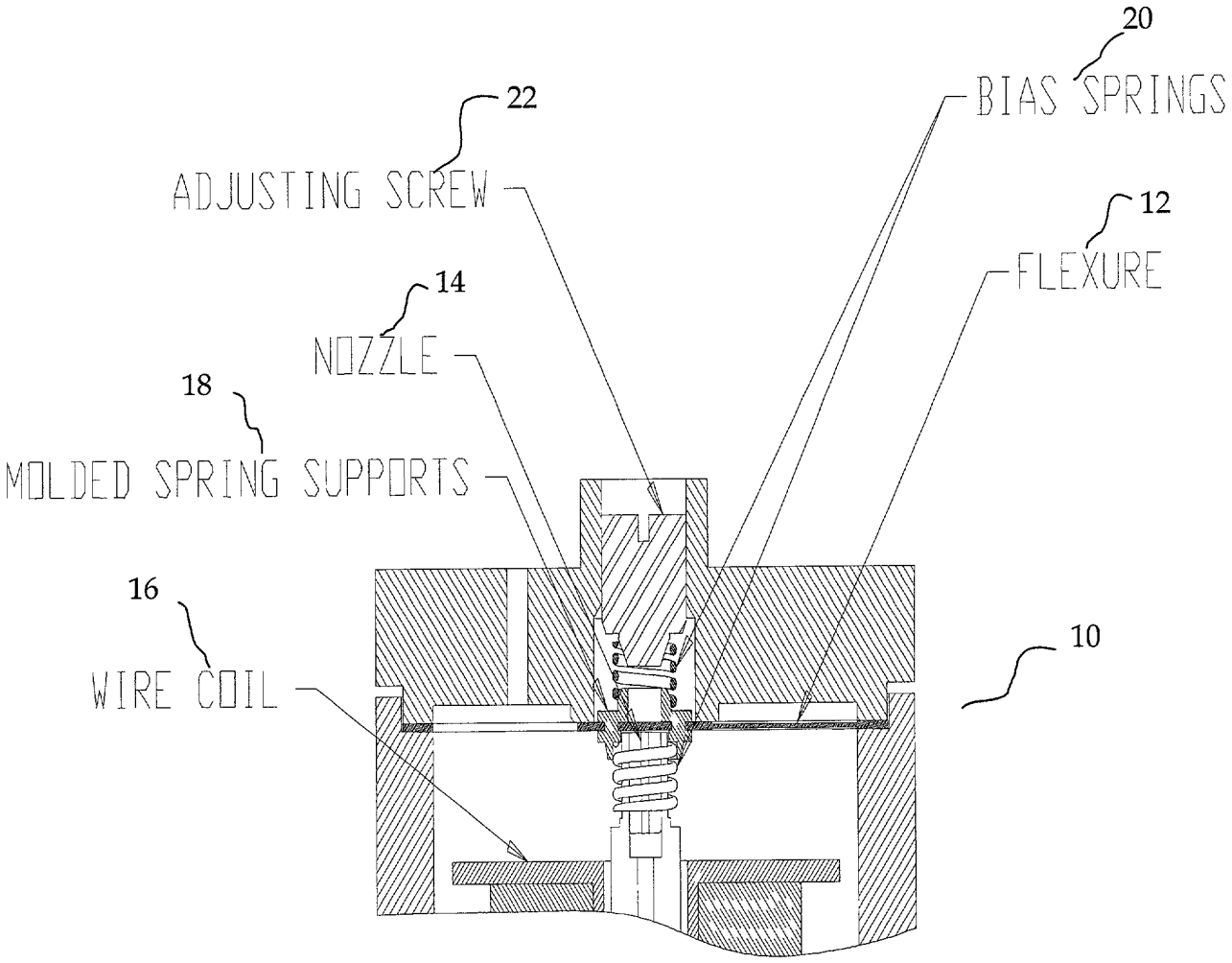
20
BIAS SPRINGS
22
ADJUSTING SCREW
12
FLEXURE
14
NOZZLE
18
MOLDED SPRING SUPPORTS
16
WIRE COIL
10

Fig. 1

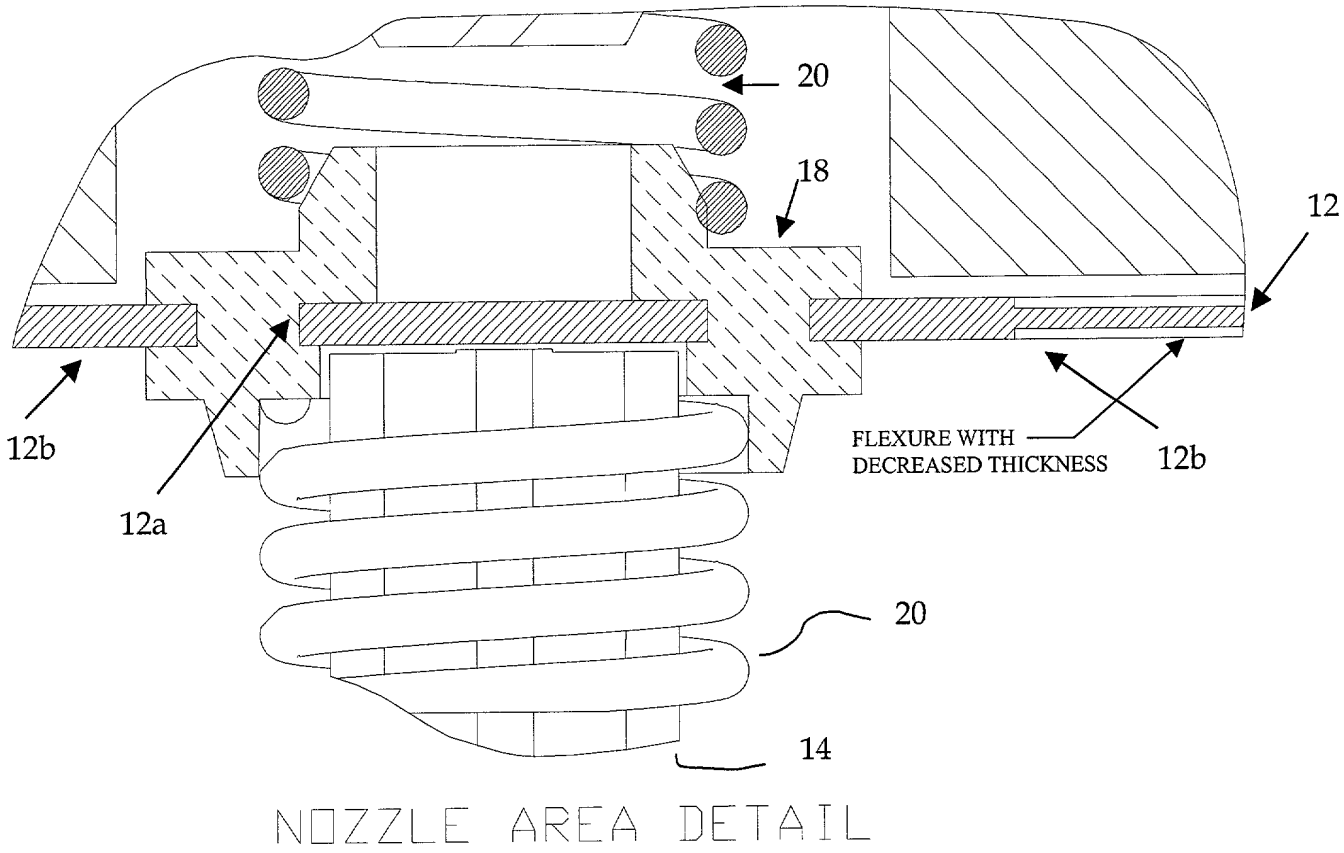
20
18
12
12b
12a
FLEXURE WITH
DECREASED THICKNESS
12b
20
14
NOZZLE AREA DETAIL

Fig. 2

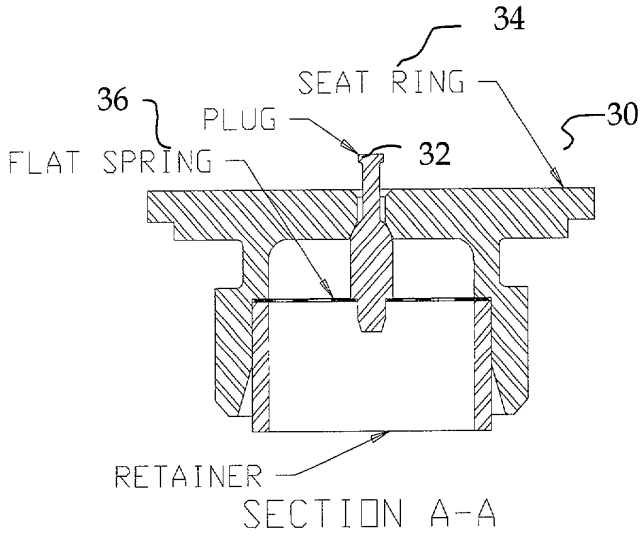
34
SEAT RING
36
PLUG
30
FLAT SPRING
32
RETAINER
SECTION A-A

Fig. 3B

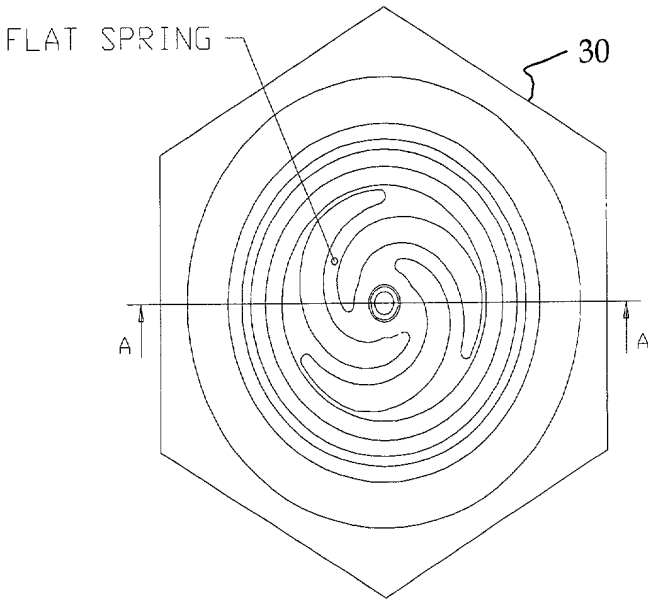
FLAT SPRING
30
A
A

Fig. 3A

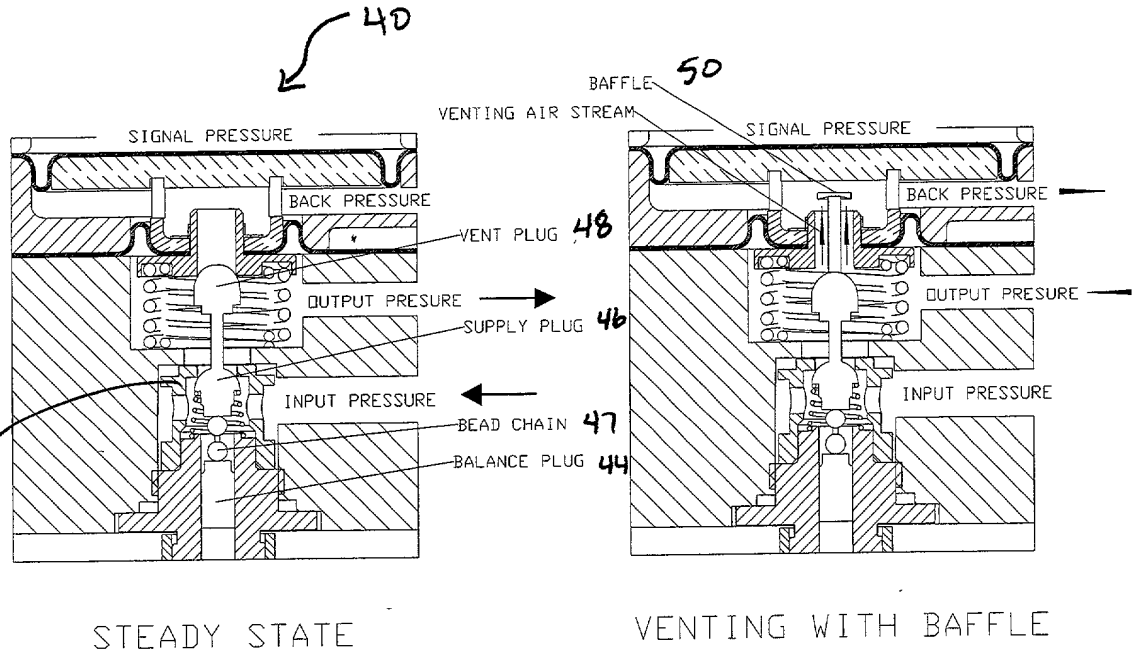
40
SIGNAL PRESSURE
BACK PRESSURE
VENT PLUG 48
OUTPUT PRESURE
SUPPLY PLUG 46
INPUT PRESSURE
BEAD CHAIN 47
BALANCE PLUG 44
42
STEADY STATE
BAFFLE 50
VENTING AIR STREAM
SIGNAL PRESSURE
BACK PRESSURE
OUTPUT PRESURE
INPUT PRESSURE
VENTING WITH BAFFLE

Fig. 4A

Fig. 4B

DOCKET NO: 26334.8

DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

As below named inventors, we hereby declare that:

Our residence, post office address and citizenship are as stated below next to our names;

We believe that we are the original inventors of the subject matter which is claimed and for which a patent is sought on the invention entitled as set forth below, which is described in the specification of which: (check one)

X is attached hereto.

_____ was filed on _____
under Attorney's Docket Number _____
as Application Serial No. _____
and was amended on _____ (if applicable).

VALVE POSITIONER SYSTEM

We hereby state that we have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

We acknowledge the duty to disclose information which is material to the patentability of this application in accordance with 37 CFR 1.56.

We hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 USC 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

DOCKET NO: 26334.8

POWER OF ATTORNEY: As the named inventors, we hereby appoint the following attorneys and/or agents to prosecute this application and transact all business in the Patent and Trademark Office connected therewith.

Theodore Baroody	Reg. No. 45,417	Christopher R. Kosh	Reg. No. 42,760
Jeffrey M. Becker	Reg. No. 35,442	Michael J. Balconi-Lamica	Reg. No. 34,291
James R. Bell	Reg. No. 26,528	Todd Mattingly	Reg. No. 40,298
Daniel E. Burke	Reg. No. 46,588	David L. McCombs	Reg. No. 32,271
L. Howard Chen	Reg. No. 46,615	William R. Naifeh	Reg. No. 44,962
Randall E. Colson	Reg. No. 40,566	David M. O'Dell	Reg. No. 42,044
Michael A. Davis, Jr.	Reg. No. 35,488	Michael D. Pegues	Reg. No. 38,993
Ruben C. DeLeon	Reg. No. 37,812	Phillip B. Philbin	Reg. No. 35,979
Brian J. Hubbard	Reg. No. 45,873	Constance M. Pielech	Reg. No. 46,991
Rita M. Irani	Reg. No. 31,028	Brandi W. Sarfatis	Reg. No. 37,713
Warren B. Kice	Reg. No. 22,732	David O. Simmons	Reg. No. 43,124

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FULL NAME OF FIRST INVENTOR: **Harold R. Smart**

INVENTOR'S SIGNATURE: Harold R Smart DATED: 10-25-00

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FULL NAME OF SECOND INVENTOR: **Chuhe Zhou**

INVENTOR'S SIGNATURE: ______________ DATED: 10/25/00

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